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(11) Publication number : **0 581 610 A1**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number : 93306062.6

(51) Int. Cl.⁶: B32B 17/10, C03C 10/00

(22) Date of filing : 30.07.93

(30) Priority : 30.07.92 JP 223470/92

(43) Date of publication of application :
02.02.94 Bulletin 94/05

(84) Designated Contracting States :
DE FR GB

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(54) Fire-protection and safety glass panel.

(57) In a fire-protection and safety glass panel having a transparent appearance and dual functions as a fire protection glass for shutting out flame and smoke for a long period of time upon occurrence of fire and as a safety glass which is neither shattered into pieces and nor forms any through hole if it is broken in an ordinary life, a PET (polyethylene terephthalate) film (12) is arranged between a first glass plate (10) and a second glass plate (11). The first and the second glass plates (10 and 11) and the PET film (12) are adhered through transparent acrylic adhesive agent layers (13 and 14), respectively. An intermediate resin layer comprises the PET film (12) and the adhesive agent layers (13 and 14) and has a thickness between 75 and 200 μm .

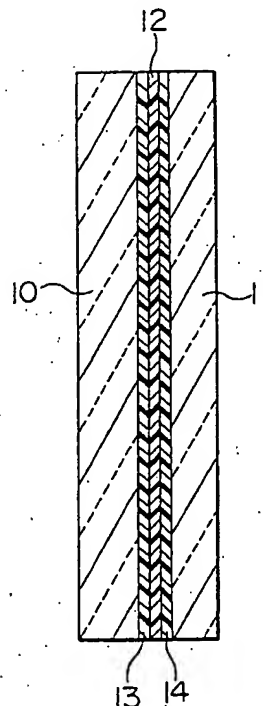


FIG. 1

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Background of the Invention:

This invention relates to a fire-protection and safety glass panel which serves as a fire-protection panel upon occurrence of fire and as a safety glass panel during normal use.

5 With recent increase of large-sized architectures such as multistory buildings, department stores, and supermarkets, there is a demand for a fire-protection and safety glass panel having dual functions as a fire protection panel for shutting out flame and smoke upon occurrence of fire to thereby suppress the spread of the fire at a minimum and as a safety glass panel which is neither shattered into pieces and nor forms a through hole if it is broken during normal use.

10 A conventional fire-protection panel comprises a low-expansion crystallized glass plate, a borosilicate glass plate, or a wire mesh glass plate (a wire glass plate). On the other hand, a conventional safety glass panel comprises a laminated glass plate including a plurality of soda lime glass plates and a transparent polyvinyl butyral film or films (PVB film) joined by thermocompression bonding to provide a structure which comprises a plurality of glass plates with an intermediate resin layer or layers interposed therebetween. Another
15 conventional safety glass panel comprises a soda lime glass plate with an antishattering film applied on a surface thereof. However, a fire-protection and safety glass panel which has both a fire protection function and a safety function has not yet been known.

If the safety glass panel is heated upon occurrence of fire, it is thermally cracked to form a through hole. In particular, when the above-mentioned laminated glass plate is heated, the PVB film is decomposed to produce a combustible gas. The gas is blown to a nonheated side and inflamed to accelerate the spread of the
20 fire. For thermocompression bonding of the transparent film, a large-sized heating furnace is required so that the laminated glass plate is completely received therein. Furthermore, when a plurality of the glass plates have different thermal expansion coefficients and the PVB film is thermocompression bonded to the glass plates to provide an intermediate resin layer therebetween, a warp is caused to occur due to the difference in contraction of the glass plates during cooling.

25 On the other hand, the low-expansion crystallized glass plate or the borosilicate glass plate used as the fire protection panel is easily broken, during normal use, due to mechanical impact causing the plate to be shattered into pieces or dropped off. The wire mesh glass plate has a safety effect to some extent. However, if the glass plate is subjected to a great impact, for example, due to strong collision of a human body, a wire mesh will be cut off to form a through hole. In this event, the human body may be injured.

30 There are known incombustible transparent films such as a fluoroc resin film. However, this film is very expensive and slightly opaque. Accordingly, it is difficult to obtain a laminated glass panel having a high transparency. In addition, this film is poor in evenness. When this film is adhered to the glass plate, air bubbles easily enter into a gap formed therebetween. It is therefore difficult to obtain a transparent appearance.

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Summary of the Invention:

It is therefore an object of this invention to provide a fire-protection and safety glass panel having dual functions as a fire-protection glass panel for shutting out flame and smoke for a long period of time on occurrence of fire and as a safety glass which is neither shattered into pieces nor forms a through hole if it is broken during normal use.

40 It is another object of this invention to provide a fire-protection and safety glass panel of the type described, which has a transparent appearance.

45 It is still another object of this invention to provide a glass window comprising a fire-protection and safety glass panel having dual functions as a fire-protection glass panel for shutting out flame and smoke for a long period of time on occurrence of fire and as a safety glass panel which is neither shattered into pieces nor forms a through hole if it is broken during normal use.

It is yet another object of this invention to provide a glass window of the type described, which comprises the fire-protection and safety glass panel having a transparent appearance.

50 It is a further object of this invention to provide a glass door comprising a fire-protection and safety glass panel having dual functions as a fire-protection glass panel for shutting out flame and smoke for a long period of time on occurrence of fire and as a safety glass panel which is neither shattered into pieces nor forms a through hole if it is broken during normal use.

55 It is a still further object of this invention to provide a glass door of the type described, which comprises the fire-protection and safety glass panel having a transparent appearance.

Other objects of this invention will become clear as the description proceeds.

A fire-protection and safety glass panel to which this invention is applicable comprises a first glass plate, a second glass plate opposite to the first glass plate, and an intermediate resin layer between the first and

the second glass plates. At least one of the first and the second glass plates is a heat-resistant glass plate.

According to this invention, the intermediate resin layer comprises a polyethylene terephthalate film and has a thickness which is not greater than 200 μm .

A glass window to which this invention is applicable comprises a fire-protection and safety glass panel and a sash for the fire-protection and safety glass panel. The fire-protection and safety glass panel comprises a first glass plate, a second glass plate opposite to the first glass plate, and an intermediate resin layer between the first and the second glass plates. At least one of the first and the second glass plates is a heat-resistant glass plate.

According to this invention, the intermediate resin layer comprises a polyethylene terephthalate film and has a thickness which is not greater than 200 μm .

A glass door to which this invention is applicable comprises a fire-protection and safety glass panel and a frame for the fire-protection and safety glass panel. The fire-protection and safety glass panel comprises a first glass plate, a second glass plate opposite to the first glass plate, and an intermediate resin layer between the first and the second glass plates. At least one of the first and the second glass plates is a heat-resistant glass plate.

According to this invention, the intermediate resin layer comprises a polyethylene terephthalate film and has a thickness which is not greater than 200 μm .

In order to achieve the above-mentioned objects, the present inventors have made extensive researches. As a result, it is found out that a material interposed in each gap between the first and the second glass plates must have a thickness not greater than a predetermined value. Even if the material is combustible or fire-retarding and the combustible gas is blown to the nonheated side, the gas is prevented from being inflamed because its density is thin.

When a heat-resistant glass plate is used as at least one of the glass plates, a fire protection effect is improved to provide a function as a fire-protection panel. Furthermore, when the polyethylene terephthalate film is used as the material interposed in each gap between the first and the second glass plates, a sufficient safety effect is obtained even if the thickness is small. This is because the tensile strength is excellent upon reception of an impact.

According to this invention, the polyethylene terephthalate film (hereinafter referred to as a PET film) is used as a material of the intermediate resin layer. This is because the film is fire-retarding and excellent in transparency and evenness. In addition, the film can be formed into an extremely small thickness, specifically, not greater than 25 μm . Furthermore, this film is excellent in strength and low in extension so that tensile strength is high even if the thickness is small.

As the heat-resistant glass plate used in this invention, glass plates including low-expansion crystallized glass plates, borosilicate glass plates, or wire glass plates may be used. Taking the transparency and the heat resistance into consideration, the low-expansion crystallized glass plate is preferable.

The low-expansion crystallized glass plate is of a crystallized glass which exhibits thermal expansion substantially equal to zero upon occurrence of fire. Specifically, a preferable crystallized glass has a composition consisting by weight of 3-5% Li_2O , 20-35% Al_2O_3 , 55-70% SiO_2 , 1-3% TiO_2 , 1-4% ZrO_2 , 1-5% P_2O_5 , 0-4% Na_2O , 0-4% K_2O , 0.5-4% $\text{Na}_2\text{O}+\text{K}_2\text{O}$, precipitates β -quartz solid solution crystals, and has a thermal expansion coefficient between $-10 \times 10^{-7}/^\circ\text{C}$ and $-15 \times 10^{-7}/^\circ\text{C}$ (30-750 $^\circ\text{C}$).

According to this invention, at least one of the first and the second glass plates is a heat-resistant glass plate. Each of the other glass plates does not need to be a heat-resistant glass plate but may be a soda lime glass plate.

When the borosilicate glass plate or the soda lime glass plate is used in this invention, it is preferable to chemically or thermally reinforce the glass plate in order to improve the impact resistance.

The transparent adhesive agent used in this invention may be any appropriate material which is excellent in transparency, and strong in adhesion so that a large-sized glass plate and the PET film can be strongly bonded. It is preferably available at low cost. At present, only combustible and fire-retarding materials satisfy all of the above-mentioned properties. Taking a material cost and a workability into consideration, acrylic or vinyl transparent adhesive agents are preferable.

In order to prevent air bubbles from entering into a gap between the glass plate and the intermediate resin layer as little as possible, it is preferable to use a glass plate having a surface undulation not greater than 2 microns and to suppress a surface undulation of a transparent adhesive agent coated on the PET film to a value not greater than 2 microns.

According to this invention, at least one glass plate comprises a heat-resistant glass plate. When the glass plate is heated upon occurrence of fire, no through hole allowing passage of flame and smoke is formed during a predetermined period of time so that the spread of the fire can be avoided.

According to this invention, it is sufficient that at least one glass plate is a heat-resistant glass plate. Each

of the other glass plates does not need to be a heat-resistant glass plate but may be a soda lime glass plate.

According to this invention, each intermediate resin layer desirably has a thickness not greater than 200 μm , preferably, not greater than 100 μm . The reasons are as follows.

The first reason will be described. When the fire-protection and safety glass panel according to this invention is heated upon occurrence of fire, the PET film and the transparent adhesive agent forming the intermediate layer are decomposed to produce the combustible gas. If the intermediate resin layer has a thickness not smaller than 200 μm , a large amount of the combustible gas is produced so that the high-density gas is blown to the nonheated side. The gas will be inflamed by the heat of the fire to thereby spread the fire.

The second reason is as follows. When the fire-protection and safety glass panel according to this invention is heated upon occurrence of fire and the intermediate resin layer has a thickness not smaller than 200 μm , a large amount of the combustible gas will be produced as described above. This increases a pressure in the gap between the glass plates. Due to the pressure, the glass plate is easily broken.

The PET film is excellent in strength and low in extension. Accordingly, even if the thickness is small, the fire-protection and safety glass panel according to this invention has an excellent tensile strength. When the glass panel is subjected to an impact, deformation of the glass plate is suppressed and a high impact resistance is obtained.

Brief Description of the Drawing:

Fig. 1 is a sectional view of a fire-protection and safety glass panel according to an embodiment of this invention;
Fig. 2 is a front view of a glass window using the fire-protection and safety glass panel illustrated in Fig. 1; and
Fig. 3 is a perspective view of a glass door using the fire-protection and safety glass panel illustrated in Fig. 1.

Description of the Preferred Embodiment:

Referring to Fig. 1, a fire-protection and safety glass panel according to a preferred embodiment of this invention comprises a first glass plate 10, a second glass plate 11 opposite to the first glass plate, and an intermediate resin layer between the first and the second glass plates 10 and 11. At least one of the first and the second glass plates 10 and 11 is a heat-resistant glass plate. The intermediate resin layer comprises a polyethylene terephthalate film (namely, a PET film) 12 and first and second adhesive agent layers 13 and 14 and has a thickness which is not greater than 200 μm . The first adhesive agent layer 13 adheres the PET film 12 to the first glass plate 10. The second adhesive agent layer 14 adheres the PET film 12 to the second glass plate 11.

Each of the first and the second adhesive agent layers 13 and 14 may be of either a silicone adhesive agent or an acrylic adhesive agent.

Each of the first and the second glass plates 10 and 11 is preferably a transparent plate. The PET film 12 is preferably a transparent film. Each of the first and the second adhesive agent layers 13 and 14 is preferably a transparent layer.

Suitable heat-resistant glass plates include a low-expansion crystallized glass described above and a borosilicate glass. An alternative heat-resistant glass plate is of a wire glass.

Table 1 shows structures and characteristics of this invention (Samples Nos. 1-3) and comparative examples (Samples Nos. 4-6).

The samples Nos. 1-5 in Table 1 have a structure illustrated in Fig. 1. The PET film 12 is held between the first glass plate 10 and the second glass plate 11. The glass plates 10 and 11 are adhered to the PET film 12 through transparent acrylic adhesive agent layers 13 and 14, respectively. Each of the samples Nos. 1-3 has the intermediate resin layer having a thickness of 75-200 μm while the samples Nos. 4 and 5 have intermediate resin layers having thicknesses of 200 μm and 250 μm , respectively.

Each of the samples Nos. 1-5 was prepared in a method which will presently be described.

At first, the transparent adhesive agent layer 13 was applied on one surface of the PET film 12. The adhesive-applied surface was brought into contact with one surface of the first glass plate 10. One end thereof was inserted in a gap between two rubber rollers and then moved forward so that they were bonded together.

Table 1

	This Invention			Comparative Example		
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
5	Glass Plate A	Crystallized Glass	Crystallized Glass	Soda Lime Glass	Crystallized Glass	Boro-silicate Glass
10	Glass Plate B	Soda Lime Glass	Boro-silicate Glass	Soda Lime Glass	Boro-silicate Glass	Soda Lime Glass
15	Transparent Film	PET	PET	PET	PET	PVB
20	Thickness of Transparent Film (μm)	25	50	100	100	200
25	Transparent Adhesive Agent	Acrylic	Acrylic	Acrylic	Acrylic	-
30	Thickness of Adhesive Agent (μm)	25	25	50	50	25
35	Thickness of Intermediate Resin Layer (μm)	75	100	200	200	250
40	Appearance	Transparent	Transparent	Transparent	Transparent	Transparent
45	Inflammation	None	None	Self-extinguish	Not Measured	Not Measured
50	Fire Protection Time (minutes)	>180	>180	>180	17	22
55	Impact Resistance (cm)	72	120	140	140	100
	Warp (%)	<0.2	<0.2	<0.2	<0.2	1.5

Thereafter, the transparent adhesive agent layer 14 was applied on the other surface of the PET film 12. The

adhesive-applied surface was brought into contact with one surface of the second glass plate 11. In the manner similar to the foregoing, they were bonded together.

The sample No. 6 has a structure comprising a borosilicate glass plate and a soda lime glass plate with a PVB film thermocompression bonded therebetween.

5 As the crystallized glass plate in the table, use was made of a transparent crystallized glass having a dimension of 2000 x 900 x 5 mm and a thermal expansion coefficient of $-5 \times 10^{-7}/^{\circ}\text{C}$ (FIRELITE (trade name): manufactured by Nippon Electric Glass Co., Ltd.). As the soda lime glass plate, use was made of a glass plate formed into a plate shape by an ordinary float method and having a dimension of 2000 x 900 x 3 mm and a thermal expansion coefficient of $85 \times 10^{-7}/^{\circ}\text{C}$. As the borosilicate glass, use was made of a glass plate formed
10 into a plate shape by an ordinary down draw method and having a dimension of 2000 x 900 x 3 mm and a thermal expansion coefficient of $30 \times 10^{-7}/^{\circ}\text{C}$.

As is obvious from the table, each of the samples Nos. 1-3 according to this invention had a transparent appearance. In a fire protection test, no inflammation was caused at the nonheated side or, if the inflammation was caused, it was immediately self-extinguished. In addition, the fire protection time was as long as 180 minutes or more. The impact resistance was excellent and the warp was small.
15

On the other hand, each of the samples Nos. 4, 5, and 6 had a transparent appearance and an excellent impact resistance. However, in the sample No. 4 using no heat-resistant glass plate, each glass plate was broken in the fire protection test to form through holes allowing passage of flame and smoke. With the samples Nos. 5 and 6, the gas was blown to the nonheated surface and spontaneously inflamed in the fire protection
20 test so that the fire protection time was as small as 6-22 minutes. It was therefore unnecessary to test the inflammation for each comparative example. The samples Nos. 4 and 5 exhibited a small warp while the sample 6 exhibited a warp as large as 1.5%.

In the table, the appearance was visually observed.

The inflammation was measured as follows. Each sample was located with one surface faced to an electric heater of an area heating type. Heating was carried out in accordance with a standard heating curve prescribed in Official Notification No. 1125 of the Ministry of Construction of Japan. After the lapse of three minutes from the start of heating, a gas lighter was occasionally brought close to the gas blown to the nonheated side while it was observed whether or not the inflammation was caused to occur. In case when the gas lighter was inflamed, "none" is indicated. In case when the gas lighter was inflamed but no flame was produced on the non-heated side of the sample after the gas lighter was separated apart from the sample, "self-extinguish" is indicated.
25
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The fire protection time was measured by subjecting each sample to the fire protection test twice wherein each surface was faced to a heating source. The time was measured until spontaneous inflammation was caused to occur at the nonheated side of the sample or until the through hole allowing passage of flame or smoke was formed. A shorter one was selected for indication.
35

The impact resistance was examined in accordance with a shot bag test under JIS R-3205. Each sample was vertically fixed. In order to give an impact, a shot bag was made to collide with one surface of the sample with a gradual increase of a falling level. A maximum falling level H was determined at which no through hole was formed in the sample after reception of the impact and a total weight of a dropping part of the glass plate was not greater than 50g. It is understood that the impact resistance is excellent when the falling level H is high.
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The warp was measured by vertically arranging each sample and horizontally putting a straight ruler therealong. Indication is made at a percentage with respect to a horizontal length.

45 Although the above-mentioned embodiment is directed to the fire-protection and safety glass panel comprising the first and the second glass plates, this invention is not restricted thereto but is also applicable to a fire-protection and safety glass panel comprising three or more glass plates and two or more intermediate resin layers. In this case, each intermediate resin layer is disposed between adjacent ones of the glass plates.

As described above, the fire-protection and safety glass according to this invention has a transparent appearance and has dual functions as a fire-protection glass for shutting out flame and smoke during a long period of time upon occurrence of fire and as a safety glass which is neither shattered into pieces nor forms any through hole if it is broken in normal use.
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Turning to Fig. 2, a glass window comprises a fire-protection and safety glass panel 51 and a sash 52 for the fire-protection and safety glass panel 51. As the fire-protection and safety glass panel 51, the fire-protection and safety glass panel described in conjunction with Fig. 1 is used so that the window is a fire-protection and safety glass window.
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Turning to Fig. 3, a glass door comprises a fire-protection and safety glass panel 61 and a frame 62 for the fire-protection and safety glass panel 61. The fire-protection and safety glass panel of Fig. 1 is used as the fire-protection and safety glass panel 61 so that the door is a fire-protection and safety glass door. The

glass door is installed in an opening 63.

Claims

- 5 1. A fire-protection and safety glass panel comprising a first glass plate, a second glass plate opposite to said first glass plate, and an intermediate resin layer between said first and said second glass plates, at least one of said first and said second glass plates being a heat-resistant glass plate, wherein said intermediate resin layer comprises a polyethylene terephthalate film and has a thickness which is not greater than 200 μm .
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2. A fire-protection and safety glass panel as claimed in Claim 1, wherein each of said first and said second glass plates is a transparent plate, said polyethylene terephthalate film being a transparent film.
- 15 3. A fire-protection and safety glass panel as claimed in Claim 1 or 2, wherein said heat-resistant glass plate is of a crystallized glass consisting of 3-5 wt% Li_2O , 20-35 wt% Al_2O_3 , 55-70 wt% SiO_2 , 1-3 wt% TiO_2 , 1-4 wt% ZrO_2 , 1-5 wt% P_2O_5 , 0-4 wt% Na_2O , and 0-4 wt% K_2O , where a total amount of Na_2O and K_2O is 0.5-4 wt%, said crystallized glass containing β -quartz solid solution crystals.
- 20 4. A fire-protection and safety glass panel as claimed in Claim 1 or 2, wherein said heat-resistant glass plate is of a borosilicate glass.
5. A fire-protection and safety glass panel as claimed in Claim 1 or 2, wherein said heat-resistant glass plate is of a wire glass.
- 25 6. A fire-protection and safety glass panel as claimed in any one of Claims 1 to 5, wherein said intermediate resin layer further comprises a first adhesive agent layer for adhering said polyethylene terephthalate film to said first glass plate and a second adhesive agent layer for adhering said polyethylene terephthalate film to said second glass plate.
- 30 7. A fire-protection and safety glass panel as claimed in Claim 6, wherein each of said first and said second adhesive agent layers is of an adhesive agent selected from a group consisting of a silicone adhesive agent and an acrylic adhesive agent.
8. A fire-protection and safety glass panel as claimed in Claim 6 or 7, wherein each of said first and said second adhesive agent layers is a transparent layer.
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9. A glass window comprising a fire-protection and safety glass panel and a sash for said fire-protection and safety glass panel, characterised in that said fire-protection and safety glass panel is in accordance with any one of Claims 1 to 8.
- 40 10. A glass door comprising a fire-protection and safety glass panel and a frame for said fire-protection and safety glass panel, characterised in that said fire-protection and safety glass panel is in accordance with any one of Claims 1 to 8.
- 45 11. A fire-protection and safety glass panel comprising a plurality of glass plates and an intermediate resin layer between adjacent ones of said plurality of glass plates, at least one of said plurality of glass plates being a heat-resistant glass plate, wherein said intermediate resin layer comprises a polyethylene terephthalate film and has a thickness which is not greater than 200 μm .
- 50 12. A fire-protection and safety glass panel as claimed in Claim 11, wherein each of said plurality of glass plates is a transparent plate, said polyethylene terephthalate film being a transparent film.
- 55 13. A fire-protection and safety glass panel as claimed in Claim 11 or 12, wherein said intermediate resin layer further comprises a first adhesive agent layer for adhering said polyethylene terephthalate film to one of said adjacent ones of said plurality of glass plates and a second adhesive agent layer for adhering said polyethylene terephthalate film to the other of said adjacent ones of said plurality of glass plates.
14. A fire-protection and safety glass panel as claimed in any one of claims 11 to 13, wherein each of said plurality of glass plates is a transparent plate, said polyethylene terephthalate film being a transparent

film, each of said first and said second adhesive agent layers being a transparent layer.

- 5 15. A glass window comprising a fire-protection and safety glass panel and a sash for said fire-protection and safety glass panel, characterised in that said fire-protection and safety glass panel is in accordance with any one of Claims 11 to 14.

- 10 16. A glass door comprising a fire-protection and safety glass panel and a frame for said fire-protection and safety glass panel, characterised in that said fire-protection and safety glass panel is in accordance with any one of Claims 11 to 14.

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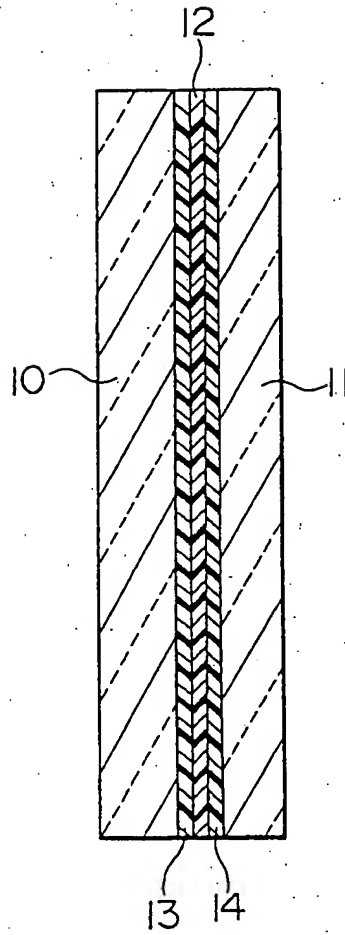


FIG. 1

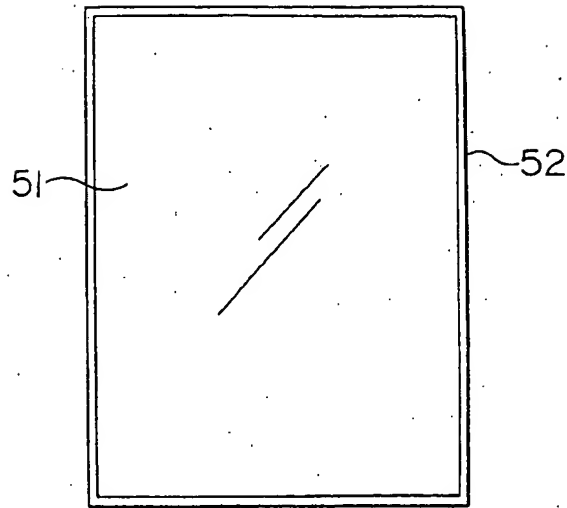


FIG. 2

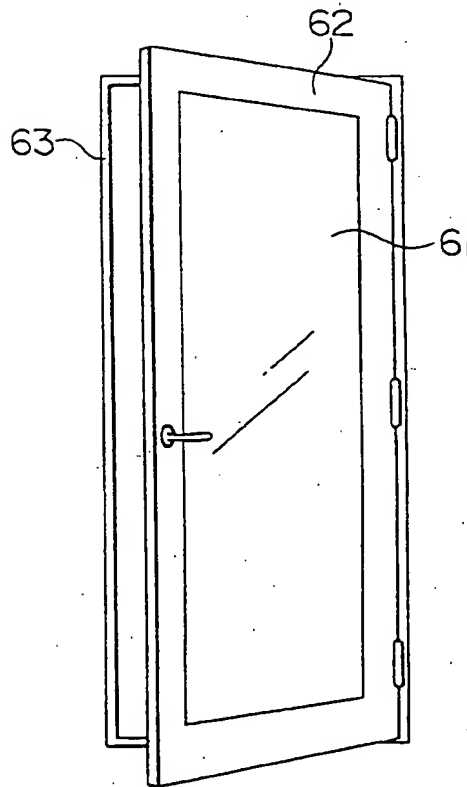


FIG. 3



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 6062

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL.5)
A	US-A-4 358 329 (SEKISUI KAGAKU KOGYO KABUSHIKI KAISHA) * column 1, line 5 - line 9 * * column 3, line 53 - line 56 * * column 4, line 14 - line 17 * * column 9, line 64 *	1,2,6, 8-16	B32B17/10 C03C10/00
A	CH-A-480 276 (FARBENFABRIKEN BAYER AG) * column 4, line 44 - line 58 *	7	
A	BE-A-684 017 (KANEKICHI HAYASHI) * claims 5-7 *	3	
A	DE-A-19 05 619 (WEBER, ROLAND) * page 3, paragraph 2; claims 2,3 *	4	
			TECHNICAL FIELDS SEARCHED (Int. CL.5)
			B32B C03C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 October 1993	Examiner VAN BELLEGHEM, W
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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